REMARKS

By this amendment, claims 2 and 8 are revised to place this application in condition for allowance. Currently, claims 1-8 are before the Examiner for consideration on their merits.

In the rejection, the Examiner relies on JP 2001 172,739 to Sumitomo to reject claims 1-8 under 35 U.S.C. § 103(a). The basis for the rejection is that although a number of features of the claims are not specifically disclosed in Sumitomo, these features would be expected to be present given that the compositional limits are met by Sumitomo and the process limitations are closely met. The Examiner further explains that Sumitomo recognizes that large size inclusions such as Ti(Nb,Zr)-C,N and Ca-Al-Mg-O need to be restricted in number and size. The Examiner concludes that to reduce the size of these inclusions is nothing more than a routine optimization of a result effective variable.

For the method claims, the Examiner asserts that it is known to control the cooling temperature in order to restrict the size and number of inclusions so as to produce a tubular good having good stress corrosion cracking. Admitting that Sumitomo does not disclose the claimed cooling conditions in claims 4, 5, 7, and 8, the Examiner also contends that the claimed values are again nothing more than routine optimization.

The rejection is traversed on the grounds that Sumitomo does not establish a *prima facie* case of obviousness against either the alloy claims or the method claims. The traverse is preceded by a discussion of the invention.

INVENTION

The objective of the invention is to provide a low alloy steel that avoids the occurrence of pitting corrosion caused by inclusions and also avoids inducing sulfide stress cracking (SSC) in an acidic environment containing hydrogen sulfide.

For attaining the objective, the inventors have made various studies on the inclusions and, as a result, conceived an idea of "preliminarily forming a nucleus of oxysulfide of Al and Ca and then precipitating carbonitride of Ti, Nb and/or Zr around the nucleus thereof" and the inventors performed a number of experiments and obtained the following findings (a) to (c):

(a) The oxysulfide of Al and Ca acts as a nucleus for absorbing Ti, Nb and Zr. Therefore, when oxysulfide of Al and Ca is formed in advance, carbonitride of Ti, Nb and/or Zr can precipitate around the nucleus, resulting in precipitation of a large number of fine composite inclusions, each of which has an outer shell of carbonitride of Ti, Nb and/or Zr surrounding the nucleus of an oxysulfide of Al and Ca (hereinafter referred to as "a carbonitride composite inclusion with Al-Ca oxysulfide nucleus").

Then, the precipitation of the carbonitride composite inclusion with Al-Ca oxysulfide nucleus can suppress precipitation of the coarse carbonitride of Ti, Nb and/or Zr surrounding the nucleus of Al oxide; it can lead to precipitation of fine carbonitride inclusions not greater than 7 μm in size, even if the carbonitride of Ti, Nb and/or Zr surrounding nucleus of Al oxide precipitates.

(b) The fine precipitate of carbonitride composite inclusion with Al-Ca oxysulfide nucleus does not adversely affect the corrosion resistance.

(c) The carbonitride composite inclusion with Al-Ca oxysulfide nucleus can be obtained by cooling at a rate of not more than 500°C/min from 1500°C to 1000°C during the casting of the low alloy steel whose chemical composition is defined by the invention. It is necessary that the carbonitride composite inclusions with A1-Ca oxysulfide nucleus have a major axis of, at most, 7 μm.

Based on the compositional definition for a low alloy steel and also on cooling the steel at a rate of not more than 500°C/min from 1500°C to 1000°C during casting, the invention offers the ability control the inclusions formed in a low alloy steel such that the composite inclusions having a major diameter of not greater than 7 μm, and have a microstructure of "carbonitride composite inclusion surrounding an nucleus of oxysulfide of Al and Ca." Also, the invention allows for the control of the number of the composite inclusions with an appearance frequency of not less than 10 pieces of composites per 0.1 mm^2 of the steel cross section.

As a result of the invention, a low alloy steel and its method of making are provided that has excellent pitting resistance; it can avoid occurrence of pitting caused by the inclusions and also avoid inducing SSC. These advancements are specifically shown in Table 2 of the present specification. That is, pitting does not occur in the steels of test Nos. 1 to 7 and 14 according to the invention, which explicitly shows good pitting resistance. Then, for manufacturing a low alloy steel that contains composite of inclusions of not greater than 7 μm having a microstructure of "carbonitride composite

inclusion surrounding the Al-Ca oxysulfide nucleus", with appearance frequency of not less than 10 pieces of composites per 0.1 mm^2, Table 2 shows that such a steel can be obtained by cooling the steel having the chemical composition at a rate of not more than 500°C/min from 1500°C to 1000°C.

REJECTION

Alloy Claims

The rejection of the alloy claims based on Sumitomo is flawed for two reasons. The first reason is that the Examiner's conclusion that the claimed microstructure is found in Sumitomo by reason of its similarity in composition and processing is just not correct. The second reason is that any allegation of obviousness based on Sumitomo is rebutted by the Applicant's discovery and comparative evidence showing that the invention offers unexpected benefits when compared to Sumitomo.

Sumitomo describes the following oil well steel material as:

> A steel for oil well excellent in sulfide stress crack resistance comprising, by mass%,
> C: 0.15 - 0.30%, Si: 0.05 - 1.0%, Mn: 0.10 - 1.0%, P: 0.025% or less, S: 0.005% or less, Cr: 0.1 - 1.5%, Mo: 0.1 - 1.0%, Al: 0.003 - 0.08%, N: 0.008% or less, B: 0.0005 - 0.010%, Ca+O (oxygen): 0.008% or less and, further, comprising at least one of Ti: 0.005 - 0.05%, Nb: 0.05 or less, Zr: 0.05% or less and V: 0.30 or less; and the balance Fe and inevitable impurities, in which the property of the inclusions in the steel can satisfy the following formulae (a) and (b):
> $Lx \leq 80$ µm (a)
> $Kz \leq 10/100$ mm^2 (b)
> wherein
> Lx: maximum length of continuous non-metal inclusions under cross sectional microscopic observation, and
> Kz: number of non-metal inclusions with a grain size of 20 µm or more per 100 mm^2 of cross section under cross sectional microscopic observation.

Sumitomo describes only "a low alloy steel for oil well having high strength required for use of oil well and having excellent SSC resistance corresponding to the strength", which "can simplify the manufacturing process and can stably produce a steel pipe for oil well having high strength excellent in SSC resistance at a reduced manufacturing cost," see paragraph [0050] thereof.

To achieve Sumitomo's purpose, the maximum length Lx and the number Kz of the inclusions are controlled such that the properties of the inclusions in the steel can satisfy the formulae (a) and (b) by means of increasing the cooling rate during continuous casting and, at the same time, controlling casting temperature using tundish heater or promoting removing coarse inclusions up, see paragraph [0036].

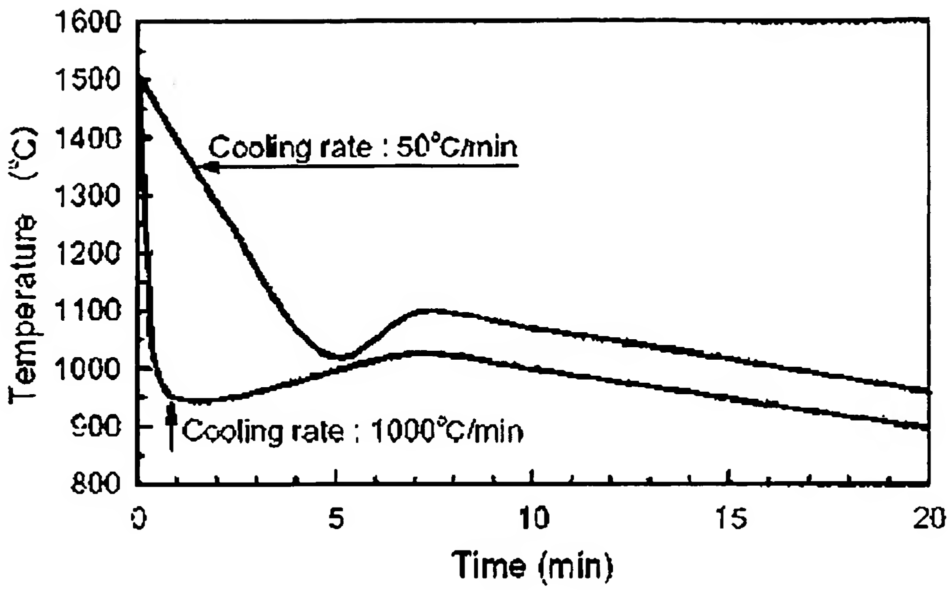
Although Sumitomo discloses obtaining a low steel pipe for oil well having high strength excellent in SSC resistance by controlling the size and the number of the inclusions of Al-Ca oxides or Ti carbonitrides so as to satisfy the formulae (a) and (b), it is undisputed that Sumitomo does not discloses the claim limitations regarding a composite of inclusions of not greater than 7 μm having a microstructure of "carbonitride composite inclusion surrounding the Al-Ca oxysulfide nucleus."

The flaw in the rejection is the presumption that the claim features recited above are found in Sumitomo because of the overlap in composition and similarity in processing. A similarity in processing does not produce the invention; the processing of the invention is critical in obtaining the claimed structure. That is, the compositional definition of a low alloy steel **together with the definition for the cooling rate**

leads to a low alloy steel which is controlled to obtain the composite inclusions having microstructure with the major axis of not greater than 7 µm and a composite inclusion structure of carbonitrides surrounding a nucleus of oxysulfides of Al and Ca. In addition, the processing and composition result in s defined number of the composite inclusions with appearance frequency of not less than 10 pieces of composites per 0.1 mm^2 of the steel cross section.

To support the argument of the criticality of the processing and composition, the Examiner's attention is directed to Table 2 on page 19 of the specification. Therein, a number of alloys were compared in terms of pitting resistance. Importantly, this Table shows that even alloys with elements satisfying the ranges set forth in claim 1, i.e., alloys H and I, do not exhibit the improved pitting resistance because they are not processed according to the invention in terms of the cooling rate of not more than 500°C from 1500-1000°C. This means that the assumption that the similar processing of Sumitomo will produce the claimed structure is just not correct.

To further show the criticality of the cooling rate, the Examiner's attention is directed to the following graph:



This graph plots temperature versus time for two types of cooling rates for a continuous casting operation. One rate is 1000°C/min, which corresponds to an ordinary fast cooling rate. The other rate is 50°C/min, which corresponds to a slow cooling rate falling within the range of the claimed cooling rate. As seen from this graph, the ordinary casting cooling rate of 1000°C/min gives rapid cooling in the beginning and then a slower cooling between the temperature range of 1000-750°C.

The cooling rate between the temperature range of 1500-1000°C for the slow cooling rate is much slower than the ordinary method. However, after a small rise in temperature as a result of heat recovery, the cooling using of the slow cooling rate matches the cooling using the ordinary casting cooling method. This comparison is further substantiation that the processing associated with the claimed low alloy steel is important to the creation of the claimed structure.

In light of the above, the Examiner's conclusion that the claimed structure would be found in Sumitomo is in error. Therefore, the Examiner can only allege that the alloy steel claims are obvious based on the contention set forth in the Office Action. That is, since Sumitomo recognizes that the size and number of inclusions can be controlled, their optimization in terms of size and number would be routine and not worthy of patent protection.

This second argument is also flawed. As stated above, Sumitomo develops a low alloy steel for high strength, excellent SSC resistance, simple manufacturing, and low cost manufacturing. To do this, Sumitomo increases the cooling rate and controls the casting temperature to satisfy the formulas of (a) and (b). What Sumitomo is doing is completely different from the aim of the present invention, and the mere fact that Sumitomo may defines the length of the inclusions or a specific number with respect to those inclusions that are greater than 20 microns does not lead one of skill in the art to the conclusion that limiting the inclusions to not greater than 7 microns, these inclusions having an appearance frequency on not less than 10 pieces per 0.1 mm^2 of the steel cross section is obvious. Since Sumitomo's structure is process dependent, how would one of skill in the art go about achieving the aim of the invention using Sumitomo's process? There is no guidance in this regard and the Examiner cannot baldly conclude that the limitations regarding inclusion size and number are merely optimizations of Sumitomo.

Another reason why the rejection is flawed is that Sumitomo does not suggest the composite with "an outer shell of carbonitride of Ti and/or Nb surrounding a nucleus

of oxysulfide of Al and Ca". In paragraphs 14, 15, and 28-31 Sumitomo discusses various inclusions, including those of the calcium-aluminum-oxygen system and carbonitrides of Ti with Nb and Zr. However, the broad recitation of these inclusion chemistries is not the same as the unique structure of an outer shell of carbonitride of Ti and/or Nb surrounding a nucleus of oxysulfide of Al and Ca". Lacking a disclosure of this nature in Sumitomo and any suggestion to have the claimed structure requires withdrawal of the rejection of the alloy steel claims.

To recap, it is respectfully contended that Sumitomo does not inherently teach the claimed alloy steel nor does it provide any guidance to specify the parameters of the inclusions set forth in claims 1-8 and these claims are patentable as a result of the failings of Sumitomo. In addition, the unexpected results in terms of pitting resistance when obtaining the claimed structure weighs against any allegation of obviousness based on Sumitomo.

<u>Method Claims</u>

It is also submitted that method claims 4, 5, 7, and 8 are patentable over Sumitomo. As pointed out above, the cooling of the claimed alloy steel at a rate of not more than 500°C/min from 1500°C to 1000°C during the casting of the steel produces unexpected results. Thus, even if the Examiner were to take the position that optimizing the cooling rate of Sumitomo would be an obvious exercise, the discovery that controlling the cooling rate in combination with the claimed composition to produce the claimed structure results in the improved pitting resistance rebuts any such

contention. Thus, claims 4, 5, 7, and 8 are separately patentable over Sumitomo for these reasons.

SUMMARY

To recap, it is contended that either Sumitomo fails to establish a *prima facie* case of obviousness against alloy steel claims 1, 2, 3, and 6 because the limitations therein are not taught or found to be inherent. Alternatively, the specification demonstrates that the claimed alloy steel with its structural limitations produces unexpected results that rebut any allegation of obviousness.

Method claims 4, 5, 7, and 8 are also patentable over Sumitomo based on the importance of the claimed cooling rate and the ability to produce a low alloy steel of superior pitting resistance.

Accordingly, the Examiner is respectfully requested to examine this application in light of this Amendment, and pass claims 1-8 onto issuance.

If the Examiner believes that an interview with Applicant's attorney would be helpful in expediting the allowance of this application, the Examiner is requested to telephone the undersigned at 202-835-1753.

The above constitutes a complete response to all issues raised in the Office Action dated August 17, 2005.

Again, reconsideration and allowance of this application is respectfully requested.

Please charge any fee deficiency or credit any overpayment to Deposit Account

No. 50-1088.

Respectfully submitted,

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